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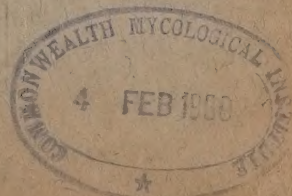
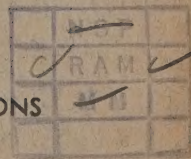
Held in Rome, Italy

6 - 13 April 1959

**FAO PANEL OF EXPERTS ON
THE USE OF PESTICIDES
IN AGRICULTURE**



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS



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REPORT OF THE
FAO PANEL OF EXPERTS
ON THE USE OF PESTICIDES IN AGRICULTURE

Held in
Rome, Italy
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Plant Production and Protection Division
Food and Agriculture Organization of the United Nations
Rome, Italy May 1959

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INTRODUCTION

The Panel of Experts on the Use of Pesticides in Agriculture was convened by the Director-General of FAO in pursuance of the recommendations of the European Commission on Agriculture and other technical groups. The European Commission on Agriculture at its 10th Session in 1958, noting the wide interest that has been shown in the safe use of pesticides and realizing the need for critical evaluation of existing information, suggested that the Director-General make efforts to strengthen activities in this field. To that end the Commission adopted the following recommendation:

THE COMMISSION

Recognizing the hazards that may result from the unwise use of pesticides especially as concerns toxic residues and the effect on flavor of treated crops, and on honey bees and other pollinators,

Considering that such hazards may be greatly reduced by the establishment and implementation of legislation governing the marketing and application of pesticides,

Having noticed that FAO, in compliance with requests of various technical meetings, has initiated activities in this field,

Recommends that the Director-General give consideration to developing a project to deal with various problems concerning pesticides in close cooperation with other international organizations interested.

The Panel consisted of seven experts in agricultural pesticides and toxicology, who were invited to serve in individual capacities. The Panel met in Rome from 6 to 13 April 1959 and undertook to review some major problems involved, with special reference to: (1) the rôle of pesticides in agriculture; (2) hazards that may arise from the use of pesticides to useful insects, to wild animals including fish, to livestock and domestic animals, to soil fertility and to flavor and quality of crops; (3) residues on or in food and feedstuff; (4) safe use of pesticides; and (5) legislative control aiming at minimizing risks in the use of pesticides.

The Panel noted that occupational hazards inherent in the manufacture and formulation of pesticides are primarily the concern of the World Health Organization and the International Labour Organization, both of which have already taken action in this matter. The Panel also noted that questions relating to intentional food additives used by the food processing industry are being dealt with by the Joint FAO/WHO Expert Committee on Food Additives.

From the beginning of its discussions the Panel realized that at its present session it would be unable to give other than a passing reference to several important aspects of the use of pesticides in agriculture. For example it is appreciated that in forestry the use of pesticides is sharply increasing, but the use of pesticides can lead to unique problems such as when applied near the borders of forest and agricultural land.

In this report, the term "pesticide" means any chemical agent used to combat injurious insects, plant disease-causing organisms, nematodes, mites, rodents, molluscs and noxious weeds.

PARTICIPATION IN THE MEETING

The following experts and FAO staff participated in the meeting of the Panel and contributed to the discussions summarized in this report.

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Dr. H.L. Haller served as Chairman and Dr. C. Logothetis as the Technical Secretary of the Panel.

Acknowledgements

The Panel thanked the Director-General of FAO for convening the meeting, and for the assistance and facilities that the Organization made available to the Panel.

ROLE OF PESTICIDES IN AGRICULTURE

Although farmers and government officials concerned with plant protection are aware of the importance of pesticides in the production and preservation of many agricultural commodities, the public at large has little appreciation of the value of pesticides. Therefore, any statement of general principles on agricultural production aimed at enhancing the world food supply must emphasize the importance of protecting plants and animals against diseases and pests, not only during production but also in processing, storage and marketing.

Injurious pests of various kinds compete with man for his food supply, and may damage his possessions. Insects may completely or partly destroy growing crops, stored grains, and other stored foodstuffs. Insects may infest the household and damage clothing, furniture, wooden structures and cause physical discomfort to occupants. In addition, there are a number of insect parasites of livestock, while other insects cause losses through annoyance or by transmitting animal diseases. Viruses, bacteria, fungi, and nematodes are responsible for many destructive plant diseases, some of which are transmitted by insects. Weeds likewise interfere in many ways with crop production and seriously reduce the productivity of agricultural lands.

Even outside of agriculture, insects may create serious problems through their ability to attack man and harbor and transmit human diseases. The extensive and successful use of pesticides against insect vectors is improving greatly human health and is partly responsible for the increase of world population. In order to feed the growing population, the reduction of crop losses through the use of pesticides and other effective means is becoming increasingly important.

With the development of accurate scientific methods of assessing losses due to pests, it is becoming increasingly clear that those losses are of great magnitude, as shown by the following examples.

The olive fly (Dacus oleae) in the Mediterranean region is a very destructive pest causing annual losses of about 20 percent of the crop. In Italy this averages to about \$30,000,000 a year and occasionally, such as was the case in 1955, the losses amounted to 60 million dollars.

In Germany, without plant protection measures, the annual value of the grape crop would be reduced by 75 percent; indeed, commercial production of grapes would rapidly become impossible without the use of pesticides.

In an experiment conducted in Canada, a portion of an orchard was purposely sprayed only with fungicides. As a result of an uncontrolled outbreak of the cigar-case bearer (Coleophora occidentis), the total yield of 750 trees was lost at a cost of \$1,250 per acre. This is an unusual case, as under normal circumstances this type of outbreak would not occur every year and this insect could have been controlled readily with an insecticide.

Many other examples may be cited in which production of certain special crops would be eliminated without the use of pesticides. For example, in late blight areas protective sprays are absolutely essential for potato production.

EFFICIENT USE OF PESTICIDES IN AGRICULTURE

Selection of Pesticides

The decision to use a pesticide, the choice of material and manner of use will vary by country, region and district and the decision will be influenced by several factors, the importance of each varying with local circumstances. These weighting factors include adequate knowledge on the distribution and density of the pest species involved and its susceptibility to control by the pesticide under consideration, the economics of crop or animal treatment and pesticide procurement, local farming or animal husbandry practices, the availability and cost of labor and machinery, current practices on biological and cultural control, preliminary quantitative evidence that the proposed chemical control methods will produce the desired effect, data on acute and chronic toxicity to mammals and data on persistence of pesticide residues under the proposed conditions of use.

Formulation of Pesticides

Many types of formulations of active ingredients are available and the choice of the proper formulation is important. The factors mentioned above will all influence the selection of the formulation as well as the active ingredient. Pesticides generally are available in technical grades of the active ingredient as solids, liquids, wettable powders, dusts, emulsifiable concentrations, oil solutions, aerosols and on granular carriers. All of these are usually available in a variety of concentrations of the active ingredient. The choice of formulation and the advisability of its preparation locally will depend upon economic as well as technical considerations. Local conditions will have an important influence on technical details e.g. choice of emulsifiers is influenced by water hardness and the nature of the plant surfaces to be sprayed, climatic conditions will influence stability of formulations and some pesticide carriers require stabilizers to prevent breakdown of the active ingredient. Where multiple applications are involved, compatibility of materials becomes an important consideration. Advice on choice of formulation should be sought from qualified persons.

Application of Pesticides

The technology of pesticide application is a major field of study in itself. Great improvements in the efficiency of application have been achieved in recent years through the introduction of low volume sprayers, improved techniques for aerial application and the use of granular carriers for pesticides. Nevertheless much research work remains to be done to improve application techniques so as to permit the maximum amount of coverage and protection with a minimum amount of pesticide. Information is required on the optimum physical status of deposits required for the desired effect. Very little is known of the need for or the significance of a continuous type of deposit or how specific formulations can be modified to control continuity.

Similarly, elucidation of the principles governing the physico-chemical and biological relationships that determine the formation and efficiency of pesticide deposit would lead to the development of better formulations which would provide the required levels of plant protection with a minimum amount of pesticide.

Resistance of Insects to Pesticides

A great store of information is now becoming available on the genetic, toxicological, metabolic and ecological aspects of the selection of resistant populations of pest species by pesticides. In recent years this has been particularly true with insects of importance in public health. Unfortunately resistance is becoming an increasingly important and more frequently recurring phenomenon in those pest species of importance in agriculture. Agricultural scientists concerned with pesticide applications should constantly be prepared to make adequate quantitative observations on the incidence of resistance to pesticides and the reasons. Quantitative objective reports are required to determine whether resistance is being encountered or whether effects are due to poor application, poor timing or poor choice of pesticides. Background data are required on the normal variation in response to pesticides that can be expected in wild populations of economic pests.

Control of Residue Levels

The control of the persistence of pesticide residues is feasible through manipulation of formulation, time, rate and number of applications and the interval between last application and harvest, but these all must be related to the life history and habits of the pest species involved. Wind, rain, sunlight, normal chemical degradation, combination with plant and animal surfaces and metabolism in plant and animal tissues all contribute to the breakdown and elimination of residues. However, in many cases, persistent residues occur when deposits become fixed or taken up by plant waxes and cuticle, or are taken up by various animal tissues, particularly fat. Judicious choice of pesticides and information on their degradation and metabolism under a wide range of conditions are required in order to avoid unnecessary residue problems. Research is needed on how the various components of a formulation can be varied to produce a predictable residue level.

Labelling for the Efficient Use of Pesticides

Information of the greatest importance to the grower in obtaining the most efficient use of pesticides should be contained on the labels. The manufacturer, formulator and distributor have a joint responsibility in ensuring that the label contains directions for the proper use of the pesticide and all the required precautions specific to the country or district in which sale is intended. Claims for performance of the product must be evaluated for validity for the country where sale is intended and not necessarily in the country of origin.

Life History and Habits of Pests

A fundamental requirement to the efficient use of pesticides is precise and adequate information on the life history and habits of the pest species to be controlled and similar relative information on its parasites and predators in order that the time of application may be made when maximum benefits can be obtained with minimum destruction of populations of beneficial insects.

SAFE USE OF PESTICIDES

The rôles of government authority, of industry and of users in the safe use of pesticides are closely related, with perhaps the major responsibility lying with authority.

Industry's field of responsibility is twofold. It is responsible firstly to the industrial operator engaged in the manufacture and formulation of pesticides and secondly to the user of the formulated product.

The Model Code of Safety Regulations for Industrial Establishments prepared by the International Labour Office in 1954, contains a section on the manufacture and handling of chemicals, which may be of value to countries seeking guidance on the essential safety measures to be taken in the manufacture and formulation of pesticides.

As its second responsibility, industry has an obligation to users that its products are properly formulated, packed and labelled with advice on the precautions to be taken in their use to ensure the absence of residues harmful to the consumer of the treated crop.

Authorities carry the major responsibility on the safe use of pesticides. They are in a position to lay down the conditions under which a pesticide, imported or manufactured locally, is formulated, packed, transported and sold, and to ensure that the products are made available to users only in an appropriate and suitable form of packing which is adequately labelled and that the claims made on the label for efficacy and safety in use are true. They are in a position to insist that all claims on the label are supported by adequate data. According to the facilities available in their country, the authorities may themselves evaluate those data or request the assistance of others, including intergovernmental organizations, to undertake this evaluation. When the distributors are unable to meet government requirements for data on effectiveness and residue of the pesticides on crops grown in the country, the authorities may undertake to assist in obtaining the necessary information.

The authorities should be prepared to take rapid and effective action against distributors violating any regulations or agreements on the importation or manufacture and sale of pesticides and against users for the misuse of these products.

Finally authorities should take all possible steps to instruct the industry and users in the safety aspects of pesticide manufacture and use by the provision of an official advisory or extension service.

The Panel suggested that the data to be required from distributors in support of their labelling claims should include information on the chemical identity and properties of the active ingredient, its inherent acute and chronic toxicity to animals and man, the mode and rate of its application

to crops, the formulation to be used, the risks to animals and man that may arise from its use, the methods of analysis used in obtaining residue data, and symptoms of poisoning and emergency treatment including antidotes.

The production of those data can be very costly in time, money and manpower. Much of the information would apply wherever the pesticide is used so that it would be unnecessary and undesirable for authorities in different regions to demand fresh comprehensive data for the same pesticide. The Panel recommended that a joint study be initiated by FAO and WHO to determine the feasibility of establishing an International Code for the toxicological and residue data required for achievement of the safe use of pesticide. This Code will serve as a guide for the manufacturers and distributors in the production of the required data and for the authorities in their evaluation.

The user of a pesticide has the moral responsibility to meet the requirements of the authorities and the instructions of distributors with regard to the safe and proper use of the product. The Panel felt that the first step in assisting users to meet this obligation is to provide the pesticide with an adequate label. The Panel supported the recommendations of the WHO Study Group on the Toxic Hazards of Pesticides to Man with regard to labelling and suggested that labels should provide, as a minimum, the following information:

- (a) The name of the distributor.
- (b) The common name(s) of the active ingredient(s) as recommended by the appropriate national or international authority.
- (c) The type of formulation with concentration of the active ingredient(s).
- (d) The recommended uses on crops and, where appropriate, cautions against undesirable applications.
- (e) Precautions to be taken for protecting the user, the consumer of the treated crop, and wildlife, useful insects, livestock, etc.
- (f) The measures necessary to ensure the safe disposal of containers used for toxic pesticides.
- (g) A suitable indication of hazard, including, if possible, a pictorial symbol as adopted internationally for toxic substances.
- (h) The recommended first aid treatment in case of intoxication.

The Panel noted also the interest being taken by WHO, ILO and the United Nations Committee of Experts on the Transport of Dangerous Goods on the labelling and classification of dangerous chemicals in international trade and the need to establish standards of safe packing.

SAFE USE OF PESTICIDES

The rôles of government authority, of industry and of users in the safe use of pesticides are closely related, with perhaps the major responsibility lying with authority.

Industry's field of responsibility is twofold. It is responsible firstly to the industrial operator engaged in the manufacture and formulation of pesticides and secondly to the user of the formulated product.

The Model Code of Safety Regulations for Industrial Establishments prepared by the International Labour Office in 1954, contains a section on the manufacture and handling of chemicals, which may be of value to countries seeking guidance on the essential safety measures to be taken in the manufacture and formulation of pesticides.

As its second responsibility, industry has an obligation to users that its products are properly formulated, packed and labelled with advice on the precautions to be taken in their use to ensure the absence of residues harmful to the consumer of the treated crop.

Authorities carry the major responsibility on the safe use of pesticides. They are in a position to lay down the conditions under which a pesticide, imported or manufactured locally, is formulated, packed, transported and sold, and to ensure that the products are made available to users only in an appropriate and suitable form of packing which is adequately labelled and that the claims made on the label for efficacy and safety in use are true. They are in a position to insist that all claims on the label are supported by adequate data. According to the facilities available in their country, the authorities may themselves evaluate those data or request the assistance of others, including intergovernmental organizations, to undertake this evaluation. When the distributors are unable to meet government requirements for data on effectiveness and residue of the pesticides on crops grown in the country, the authorities may undertake to assist in obtaining the necessary information.

The authorities should be prepared to take rapid and effective action against distributors violating any regulations or agreements on the importation or manufacture and sale of pesticides and against users for the misuse of these products.

Finally authorities should take all possible steps to instruct the industry and users in the safety aspects of pesticide manufacture and use by the provision of an official advisory or extension service.

The Panel suggested that the data to be required from distributors in support of their labelling claims should include information on the chemical identity and properties of the active ingredient, its inherent acute and chronic toxicity to animals and man, the mode and rate of its application

and those of their neighbors are kept away from the areas both during and after treatment. On large scale operations it is desirable that there should be coordination between the applicators and farmers before pesticides application is made.

Wildlife Including Birds and Fish

Incidence of damage to fish and wildlife is most frequent where large scale operations involving use of pesticides are undertaken. However, when such large scale operations are in the planning stage, the authorities responsible should consult fish and wildlife conservation officials in order that the operations may be carried out in such a way as to minimize or eliminate damage to fish and wildlife.

Operations by individual growers can result in a total loss of wildlife of significant proportions. This loss can be avoided by taking precautions such as clearing fields of wildlife before application and avoiding contamination of rivers and waterways.

The Panel was aware that there is a great body of literature in many parts of the world pertinent to this question. It recommended that FAO take the initiative to accumulate such information and make it available to other organizations interested in the problem.

Soil

Repeated application of certain pesticides to the soil can be harmful to soil fertility and its contained microorganisms, leading to low yields or even failure of crops subsequently grown in the soil. The Panel recommended that further studies in this respect be undertaken.

Residues

Residues in food have always been important from the viewpoint of the consumer. While new pesticides offer improvement in effectiveness, they are not free from disadvantages. Many of them are also poisonous to man and some of them also leave residues. But this does not necessarily mean that they present a hazard to man and domestic animals. There is a tendency by some to confuse poisonous with hazardous. The terms are not synonymous. A poison is a substance that has the capacity of producing injury; hazard is the probability that injury will result from the use of the substance in the quantity and in the manner recommended.

The Panel was in accord with the statements of the Food Protection Committee of the Food and Nutrition Board, National Research Council, U.S.A., Publication 470, November 1956, on the factors influencing amount of residue; those factors may be summarized as follows: (1) Rate of application; (2) time of application relative to the development of edible plant parts,

exposure of edible parts to treatment, time elapsed between last application and crop harvest; (3) rate of loss of a pesticide deposit from the plant, rate of decomposition or degradation of active ingredient as affected by (i) fluctuations in temperature, moisture, sunlight, (ii) plant secretions; rate of evaporation of volatile materials as affected by environmental conditions; rate of erosion of residual deposits as affected by rainfall and wind; (4) dilution due to growth of plant; (5) adherence to or absorption by plant parts; (6) efficiency of residue removal methods and extent of their use; (7) miscellaneous practices in application: (i) effect of changes in formulation on any of the listed factors; (ii) number of applications and, particularly, the date of last application.

The Panel recommended that governments and the chemical industry as a whole should encourage research leading to the establishment of principles governing residue metabolism and decay.

Furthermore, the Panel recommended that, as there are strong but varying opinions on the hazards to consumers from residues, this subject be given careful joint study by FAO and WHO.

PUBLIC RELATIONS AND PESTICIDE USE

There is a trend today in some parts of the world, which has resulted in attacks on the proponents of the intelligent and safe use of pesticides in food production. The world owes a great debt to those individuals whose work is devoted to saving crops, forests and livestock from the devastation that would follow uncontrolled attacks of pests. Governments in general and public health agencies in particular are being subjected to formidable pressure from militant vocal pressure groups.

While in some countries the contrary may be true, in others too great a proportion of popular writing and lecturing on the subject of pesticide contamination of food and the associated hazards is based on speculations, half-truths and selected obsolete information. The doubts and fears of the public have not been allayed by the more sober but less exciting facts, since when these facts are made available, they invariably receive only a fraction of the publicity given to the sensational alarmist reports.

Government agencies and the chemical industry are continuously devoting their efforts to the production of more effective new pesticides and the more efficient and safe use of existing ones. Enormous amounts of money and manpower are being used for this subject today. Unfortunately, to date the experts who are in possession of the true facts of the hazards to human health inherent in pesticide use are prone to present the evidence only at scientific meetings and at official conferences, while the ill-informed people, including some misguided but well-intentioned and competent scientists, attract attention from public platforms.

The Panel considered that it would be in the best interest of all if these controversial matters could be resolved by recognized competent scientists in authoritative national or international forums in which the interests of agriculture and public health could be harmonized. Another important step is the dissemination to the public of adequate information on the precautionary methods now employed to protect their interests. The Panel recommended that a joint study of the subject be undertaken by FAO and WHO to suggest ways and means to achieve this end.

LEGISLATIVE CONTROL OF PESTICIDE RESIDUES

Residue Tolerances

Recognizing the extremely complicated nature of this problem and the many courses which may be followed in attempts to solve it, at its present session, the Panel was able only to make a provisional assessment.

Some countries have already taken steps to control the amount of pesticide residues that may remain in or on food whilst others are considering the need for appropriate action. A wide variety of approaches are possible to this subject. They range from (1) comprehensive legislation covering all stages in the use of pesticides and culminating in official tolerances; (2) legislation on, for example, a minimum interval between final application and harvest, either with or without tolerances; to (3) restrictions on the sale of highly toxic pesticides and the control of their use by means of voluntary registration schemes and the publication of official recommendations based on unpublished "administrative" tolerances. There is a universally recognized need for legal measures to deal with the ill-principled or ignorant grower who, in failing to follow advice on the use of a pesticide, produces food containing harmful residues. However, it should be recognized that caution is necessary in an approach to the matter of regulation and legislation, since an unrealistic attitude to the problem of controlling pesticide residue levels in food can, and has, resulted in some unnecessarily severe restrictions on plant and animal protection practices, leading to losses of food supplies.

Scientists engaged in the investigation of pesticide use should strive to obtain the required economic level of protection of plants and animals using minimum amounts of pesticides. Growers must be encouraged to rely upon and observe the instructions contained on the labels for the use of the pesticide. The industry and the government are jointly responsible to ensure that the instructions on the label for use in that country or district are such that harmful residue levels will not result if the instructions are followed.

The Panel recognized that the responsible authorities, in their concern for the purity of foodstuffs, may take an over-cautious attitude, which overlooks the interest and requirement of agriculture for the effective use of pesticides. The Panel appreciated also that the establishment of unnecessarily low tolerances may result in a restriction of international trade or even be used in the place of tariff barrier.

The Panel recognized the need for the control of pesticide residue levels in food commensurate with the real hazard produced by such residues. It was aware that there are shortcomings in some of the present considerations and methods of establishing tolerances and in some of the principles now employed in calculating the relative "safe levels". The Panel was entirely sympathetic

in its understanding that the establishment and the enforcement of tolerances and harmonizing these with the requirements of agriculture is an exceptionally complicated subject. However, the Panel also appreciated that it is unrealistic to establish tolerances in the absence of analytical methods adequately sensitive and reproduceable at the level of sensitivity required for determining residues on or in the crop or animal product. There are other weaknesses which can be cited, such as (1) the existence of tolerance limits which cannot be explained by scientific facts; (2) the unrealistic situation of carrying out routine agricultural protection practices in the face of zero tolerances, especially when there is room to doubt if some zero tolerances are necessary and can be met in practice, and (3) the soundness of the "wet weight" versus the "dry weight" method of calculating residues.

The Panel was of the opinion that each government should appraise its own situation to determine what policy of control is best suited to its requirements, including its ability to administer and to provide the technical service required by the chosen system. The system chosen may be a legislative approach with published tolerances or restrictive dates of last application, or it may be a voluntary system based on recommendations for the use of pesticides supported by unpublished "administrative" tolerances. Some governments may feel that at present their best course is to restrict the import and sale of pesticides, and to place all the responsibility for supervising pesticide application under a relatively limited number of qualified personnel. With others, lack of ability to enforce and service legislation may not necessarily be a deterrent to the promulgation of legislation, since the mere existence of published regulations may be sufficient to discourage malpractices.

The Panel strongly advised that any country setting up an advisory body to consider the establishment of regulations for controlling pesticide residue levels should ensure that, in addition to public health interests, agricultural pesticide and plant and animal protection interests are represented in that body.

The Panel recommended that FAO and WHO initiate a joint study to determine the principles for the regulation of pesticide residues and for the establishment of residue tolerances.

Residue Analysis

The Panel was able to consider, in a preliminary way only, the question of residue analytical methods. It must be clearly understood that the problems and practices concerning the analysis of pesticide formulations are distinct from and seldom interrelated with those concerning the analysis of pesticide residues. The enforcement of tolerances implies the existence of adequate methods of residue analysis with facilities and manpower to carry them out.

It is necessary to have a knowledge on the degradation or metabolic products of a pesticide occurring as a residue on or in food materials before adequate analytical methods can be devised. The levels at which they occur

indicate that extremely sensitive methods are required. The wide differences in the structure of plant and animal materials in which residues occur would require that any one method for a selected pesticide may need some degree of modification for each foodstuff to which it is applied.

The methods of residue analysis may be chemical (including biochemical), biological or a combination of the two; they are frequently very complicated and time-consuming, and require expensive apparatus and highly skilled personnel for their successful application.

These factors may cause variations in the results obtained by different workers or laboratories with any one set of samples, unless the method of analysis adopted has been subjected to collaborative study by these workers and laboratories. Such a study would ensure that the method is adequate in its range and applicability and sufficient in its specificity, sensitivity and reproducibility.

Because existing methods have seldom been so evaluated, the Panel urged that all reports and publications containing residue data should adequately quote the method used, together with information on its sensitivity as applied to the foodstuffs examined.

The Panel recommended that FAO consider undertaking a study of the problem of analytical methods for pesticide residues in food.

CONCLUSIONS AND RECOMMENDATIONS

Having considered various aspects relating to the use of pesticides in agriculture, the Panel concluded and recommended as follows:

1. Although it is generally recognized that the losses caused by pests are enormous, the Panel considered that true losses can only be assessed through the development of quantitative statistically sound methods.

2. Although pesticides are necessary in the commercial production of adequate food supplies, they may be harmful when used improperly. The Panel therefore recommended that research be initiated or intensified on:

- (a) the effects of pesticides on crop quality; and
- (b) the effects of repeated application of pesticides on soil microorganisms and soil fertility.

The Panel further recommended that FAO

- (a) take the initiative in accumulating and disseminating information on the effects of pesticides on wildlife; and
- (b) urge authorities responsible for the execution of large scale pest control operations to seek the cooperation of fish and wildlife conservation officials in the planning stage of operations in order to keep losses to a minimum.

3. Although adequate control of many pests is possible today, the Panel was of the opinion that in many instances costs may be reduced, efficiency increased, residue levels controlled and the incidence of resistance to pesticides minimized with further study. Therefore the Panel recommended that research be initiated or intensified on:

- (a) the variation in response to pesticides that can be expected in normal, naturally occurring populations of economic species of insects prior to application of pesticides and after repeated application of pesticides;
- (b) the improvement of spray application techniques with the elucidation of principles governing dispersal and deposition, in order to obtain maximum amount of coverage and protection with minimum amounts of pesticides;

- (c) the determination of the optimum physical state of pesticide deposits and the principles governing the physico-chemical and biological relationships that determine the formation and efficiency of deposits; such studies would lead to the development of better formulations with more predictable performance;
- (d) the manner in which various components of a pesticide formulation can be varied in order to produce predictable residue levels; and
- (e) the elucidation of the principles of residue metabolism and decay in and on food plants during growth especially in order to reduce the present extensive requirements for the determination of residues at harvest.

4. The Panel recommended that for the efficient use of pesticides precise information on the life history and habits of the pest species to be controlled be made available. Similar information on its parasites and predators is needed so that pesticide application may be made when maximum benefits can be obtained with the minimum destruction of the population of beneficial insects. Furthermore the Panel recommended that governments initiate or intensify research which will lead to the harmonizing of chemical and biological control practices.

5. The Panel considered the problem of pesticide residues and recommended that

- (a) governments be urged, when setting up bodies to advise on regulations designed to control pesticide residue levels, to include in those bodies, in addition to public health authorities, agricultural pesticide and plant and animal protection interests; and
- (b) governments be urged to adopt, as a minimum, the requirement concerning labelling as suggested on page 10 of this report.

6. As the validity of residue data greatly depends on the adequacy (sensitivity, reproducibility, specificity etc.) of the analytical methods used, the Panel recommended that studies be intensified on problems involved in the analysis of pesticide residues in or on foodstuffs.

7. Because the proper and safe use of pesticides is of common concern to agricultural, public health, wild life and veterinary authorities, the Panel recommended that studies be undertaken jointly by FAO and WHO on:

- (a) the hazards to consumers arising from pesticide residues in and on food and foodstuffs;

- (b) the establishment of principles governing the setting up of pesticide tolerances;
- (c) the feasibility of preparing an International Code for toxicological and residue data required in achieving the safe use of a pesticide;
- (d) ways and means of disseminating to the public adequate information on precautionary measures now employed to protect consumer interests.

8. The Panel complimented FAO in taking an active interest in agricultural pesticides and for undertaking a study of the problems arising from their use. In view of the importance of modern pesticides in the production of adequate supply of agricultural commodities for a rapidly growing world population, the Panel urged FAO to continue its interest in the study of the use of pesticides in agriculture.

